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Does deliberation change individual opinions and hence resolve the intergenerational sustainability dilemma in societies?

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Abstract

The current generation affects future generations, but the opposite is not true. This one-way nature induces the current generation to take advantage of resources without considering future generations, which we call "intergenerational sustainability dilemma (ISD)." While deliberation is known to bring a change in individual opinions and lead to a better group decision in some settings, little is known about whether it resolves ISD. We examine how deliberation changes individual opinions and then can be a resolution for ISD in societies. To this end, an ISD game (ISDG) along with interviews and questionnaires are instituted in rural and urban areas of Nepalese societies. In ISDG, a sequence of six generations, each of which consists of three people, is organized, and each generation chooses either to maintain intergenerational sustainability (sustainable option) or to maximize her own generation's payoff by irreversibly imposing a cost on future generations (unsustainable option) under "deliberative" process. Our result demonstrates that urban subjects have a wider variety of individual initial opinions and support an unsustainable option more often than do rural subjects. It also shows that individual opinions change through deliberation when subjects in a generation do not share the same initial opinion, reflecting that more urban subjects change opinions. However, we identify that such changes do not work in the direction to enhance intergenerational sustainability and thus urban generations remain to choose an unsustainable option. Our experiment demonstrates that deliberation is not a resolution for ISD.

Key Words: Intergenerational sustainability dilemma; deliberative process; opinion change

Contents

Nomenclature

IFG Imaginary future generation

ISD Intergenerational sustainability dilemma

ISDG Intergenerational sustainability dilemma game

NPR Napalese rupee

SVO Social value orientation

VDC Village development committee

1 Introduction

What the current generation does affects future generations, but the opposite is not true. This one-way nature induces the current generation to take advantage of resources without fully considering future generations, which we call the "intergenerational sustainability dilemma (ISD)," and it is claimed to be a cause of many important problems (Howarth and Norgaard, 1993, Kamijo et al., 2017, Shahrier et al., 2017, Nakagawa et al., 2018). Many intergenerational problems have occurred, such as climate change, resource depletion, biodiversity loss and long-term governmental debts. However, neither market nor democracy is known to be future-oriented in nature, and it has been pointed out that these institutions favor the current generation maximizing her benefits (Pigou, 1952, Krutilla, 1967, Garri, 2010, Thompson, 2010). Although deliberation is known to bring changes in individual opinions and to lead to a better group decision in some setting (Joseph, 1994, Konrad and Thum, 2018), little is known about whether and how deliberative process can be effective as a collective decision-making mechanism for solving ISD in societies. Therefore, this paper conducts a framed field experiments to address an ISD problem under deliberative setting.

Over the last decade, several studies have used an experimental approach to examine people's preferences and behaviors regarding intergenerational sustainability. Fisher et al. (2004) show that people become less motivated to exploit resources owing to the existence of an "intergenerational link" in an intergenerational common pool experiment. Hauser et al. (2014) demonstrate that democracy or majority voting tends to promote sustainability of intergenerational goods when a majority of people are prosocial. Kamijo et al. (2017) design and implement a laboratory experiment of ISD game (ISDG) by introducing the treatment of negotiators for future generations, claiming that the negotiators improve intergenerational sustainability. Sherstyuk et al. (2016) analyze the level of difficulties in maintaining dynamic externality by implementing laboratory experiments of a dynamic game under two types of settings: (i) infinitely living decision makers and (ii) multiple generations. They find that strategic uncertainty makes it difficult to retain dynamic externality.

Many political scientists and psychologists have studied deliberation to understand processes of

collective decisions making (Rawls, 1993, Chambers, 2003, Niemeyer and Dryzek, 2007). Several experimental studies, such as Simon and Sulkin (2002), have analyzed the role of deliberation in relation to equity and sociodemographic backgrounds, concluding that deliberative discussion can bring about fair and equitable outcomes for group members. Goeree and Yariv (2011) also conduct deliberation experiments under different institutions of majority and unanimity, reporting that deliberation promotes fair outcomes across the institutions. Ban et al. (2012) use field data from south India, suggesting that, even in heterogeneous societies, deliberation is important in that it can induce long-term agreement about priorities of providing several public goods. List et al. (2013) analyze deliberative data, showing that deliberation can help resolve the salient issues. Overall, theories and empirical studies suggest that deliberation is effective in many collective decision environments.

Irrespective of types of governance, institutions and societies, whether people care about others or future generations depends on the degrees of prosociality, trust and fairness, which are affected by the cultural and economic environment (Ockenfels and Weimann, 1999, Henrich et al., 2005, Wilson et al., 2009, Henrich et al., 2010, Brosig-Koch et al., 2011, Leibbrandt et al., 2013, Shahrier et al., 2017). Furthermore, as societies become more capitalistic and competitive, the current generation tends to become more proself, compromising sustainability (Fisher et al., 2004, Shahrier et al., 2016, 2017, Timilsina et al., 2017). Although social devices such as communication, discussion or deliberation in collective decision making are demonstrated to resolve some class of not only social but also economic problems, such as the prisoner's dilemma, public goods provision and common pool resource problems (Cardenas, 2000, Cardenas et al., 2000, Cason et al., 2012, Ghate et al., 2013), little is known about how deliberation affects individual opinions and then can be a resolution for ISD in societies.

We design and institute a series of new procedures for the ISDG and field experiment to examine whether and how deliberation changes individual opinions and hence resolves ISD in fields. In ISDG, we organize a sequence of six generations, each of which consists of three subjects, and each generation is asked to decide between maintaining intergenerational sustainability (sustain-

able option) and maximizing its own generation's payoff by irreversibly imposing a cost on future generations (unsustainable option) through deliberative discussion. As a new element of our ISDG experimental design, we conduct individual interviews after subjects finish making their generation's decision. In the interviews, we elicit each subject's "individual initial opinion" about which option she supported before and "individual final opinion" after her generation's deliberation as a personal opinion, respectively. This interview process enables us to clarify whether each subject changes her opinions over a course of deliberation. To generalize and better characterize the role of deliberation on ISD in real fields, we conduct our experiment along with a questionnaire survey for sociodemographic and psychological information in both rural and urban areas of Nepal.

2 Methods and materials

2.1 Study areas

We conduct the experiments in two kinds of Nepalese fields: (i) urban areas, such as Kathmandu, Lalitpur, Bhaktapur and Pokhara city, and (ii) rural areas of several traditional villages from Prabhat and Chitwan districts. Both areas are almost homogeneous in terms of culture, language and religion. The urban areas usually have the highest human development index (HDI) on the basis of UNDP (2014), and the population density is high. For instance, Kathmandu has a population density of 4416 people per km^2 (Central Bureau of Statistics, 2011) and is the most crowded city, with $24.3\,\%$ of the total urban population in Nepal. Big cities such as Kathmandu and Pokhara are the centers for businesses and services. The rural areas consist of different villages of the Western Hills and Central Terai, such as the Prabhat and Chitwan districts (figure 1). The population densities of Chitwan and Prabhat are 261 people per km^2 and 297 people per km^2, respectively (Central Bureau of Statistics, 2011). All of these villages are agrarian societies, and the dwellers engage in farming generation after generation. A limited number of businesses and services, typically small-scale ones, are available.

[Figure 1 about here.]

2.2 Experimental setup

We conduct an intergenerational sustainability dilemma game (ISDG), an individual interview, a social value orientation (SVO) game and questionnaire surveys to obtain critical thinking disposition and sociodemographic data in the field.

Intergenerational sustainability dilemma game and deliberation

The ISDG is implemented following the laboratory and field experiments in Kamijo et al. (2017) and Shahrier et al. (2017). Building upon these previous ISDG experiments, we add a new element of individual interviews to the experimental design, the details of which shall be discussed later. Three subjects in a group are called a generation, and each generation needs to choose between options A and B. The generation receives a payoff of X by choosing option A and the payoff $X - 300$ by choosing option B. After making a choice between A and B, the generation is asked to split the payoff associated with the option they choose among the generation members. Each of the subject's payoffs in ISDG is the sum of their generation share plus the initial experimental endowment of 300. For instance, by choosing A, the generation earns 1200 experimental points ($X = 1200$), whereas by choosing B, the generation earns 900 points ($= X - 300 = 1200 - 300$). Consequently, if members of this generation split the payoff equally among them, each member earns 400 by choosing A and 300 by choosing B as a generation share. Therefore, the total payoff of each subject with generation choice A becomes 700 ($= 400 + 300$), whereas it becomes 600 ($= 300 + 300$) with generation choice B.

Each generation is allowed to deliberate over the decision between A and B as well as how to split the generation payoff up to 10 minutes of discussion. However, when the decisions cannot be made within 10 minutes, the following rules have been applied, (1) if the generation share the group receives is positive, each member receives an initial endowment of 300 only, (2) if the generation share the group receives is negative, say, $-Z$, each member equally splits $-Z$ by three and receives the payment of $-Z/3$ plus an initial endowment of 300 (see Appendix for the details). After the generation decision between A and B, each subject undergoes an individual interview in

which she is asked to state her "individual initial opinion" and "individual final opinion" regarding supporting A or B. This individual interview is a new element compared to the preexisting ISDG experiments in Kamijo et al. (2017) and Shahrier et al. (2017), clarifying how an individual opinion changes over a course of deliberation and the role of deliberation for affecting individual opinions.

Each session consists of $18 \sim 24$ subjects, organizing a sequence of $6 \sim 8$ generations. Each generation is randomly assigned to one of the $1\text{st}, 2\text{nd}, \ldots$ and 6th generations. When the number of subjects that participated in a session are 21 or 24, we organize 7th and even 8th generations. However, they are assigned as 1st and 2nd in another sequence of generations as indicated in figure 3. One generation's decision affects the subsequent generations such that subsequent generations' payoffs decreases uniformly by 300 when the current generation chooses option A, otherwise not. For instance, suppose that $X = 1200$ and the 1st generation chooses A. Then, the 2nd generation will face a game in which they can receive 900 and 600 by choosing A and B, respectively. However, if the 1st generation chooses B, the next generation can have the same decision environment as the 1st generation faced. That is, when the 1st generation chooses B, the 2nd generation can have the game in which they can receive 1200 and 900 by choosing A and B, respectively. Following the same rule, the game continues for the rest of the subsequent two generations (i.e., between ith and $i+1$th generations). Hence, option B can be considered a "sustainable option," whereas option A is the choice that compromises intergenerational sustainability and can be considered as an "unsustainable option." In each session, the 1st generation starts ISDG with $X = 1200$, implying that the 5th and 6th generations may face the game in which options A and B are associated with payoffs of zero and -300, respectively, when previous generations keep choosing option A.[1] In ISDG, the subjects are paid $550\,\mathrm{NPR}$ ($\approx 5.00\,\mathrm{USD}$) at maximum and $350\,\mathrm{NPR}$ ($\approx 3.50\,\mathrm{USD}$) on average (The NPR stands for Nepalese rupees).

[1] When the 5th and 6th generations face the game in which options A and B are associated with zero or a negative payoff of -300, the generation members can refund themselves equally from their initial endowment of 300 to make the individual payoff be at least zero.

Individual interviews

An individual interview is conducted for each subject after her generation decides between A and B in ISDG. In this interview, we investigate the patterns of the shift in individual opinions to have supported A, B or to have been ambivalent (no ideas) coded as N as her "individual initial opinion" and "individual final opinion" before and after the deliberation, respectively. Each subject is asked to answer whether she supported A, B or N and the associated reasons "before and after" a course of deliberation. The interviewers ask questions such as (1) "your personal opinion might have been different from the group decision. At the moment of the group decision, what did you really want to support as your personal opinion?" for her "individual final opinion" and the corresponding reasons and (2) "Before the group deliberation started, what did you really support as your personal opinion?" for her "individual initial opinion" and the corresponding reasons.

The individual interviews successfully identify whether each subject changes her individual opinion to have supported A, B and/or N through deliberation. For instance, some subject is recognized to have supported A as her "individual initial opinion" before deliberation but to have ended up supporting B as her "individual final opinion" after deliberation. In this case, her opinion change is coded as AB, where the first letter represents her initial personal support for A before deliberation and the second letter does her final personal support for B after deliberation. In the same manner, we identify and code subjects' opinion changes through individual interviews, and the possible combinations of opinion changes are AA, AB, AN, BA, BB, BN, NA, NB and NN. With this information about individual opinion changes before and after deliberation, we can also identify whether each generation has a unanimous opinion agreement to decide between A and B before and after deliberation.[2]

[2]An alternative way to collect the same data of individual opinions is to incentivize or to ask each subject to reveal their opinions to support A, B and N in a timely manner, i.e., each subject is asked to reveal an "individual initial opinion" before deliberation and again asked to reveal an "individual final opinion" after deliberation. However, this timely-manner procedure does not reflect the process of real-world deliberative group decisions, and it is also reported to induce subjects to have unnecessarily strong priming and anchoring effects on individual opinions that influence group deliberations and decisions (Kahneman, 2011, Kotani et al., 2014). Qualitative behavioral research establishes that individual opinions and ideas can be truthfully elicited by individual interviews after the incidences of interest, and the appendix in this paper details our interview procedures (Brinkmann, 2014). In addition, in our pilot experiment with 48 subjects, we confirm that individual initial and final opinions elicited by our interview procedure

Social value orientation (SVO) games

An SVO experiment of the "slider method" is conducted to identify subjects' social preferences as prosocial or proself in urban and rural areas, following Murphy et al. (2011). Figure 2 shows six items of the slider measure that assign numbers to represent outcomes for oneself and for the other in a pair of persons, where the other is unknown to the subject. Subjects are asked to make one choice among the nine options for each item. Each subject chooses her allocation by marking a line at the point that defines her most preferred distribution between oneself and the other (see figure 2). The mean allocation for oneself $\overline{A}_s$ and the mean allocation for the other $\overline{A}_o$ are computed from all six items (see figure 2). Then, 50 is subtracted from $\overline{A}_s$ and $\overline{A}_o$ to shift the base of the resulting angle to the center of the circle $(50, 50)$. The index of a subject's SVO is given by SVO $= \arctan \frac{(\overline{A}_o)-50}{(\overline{A}_s)-50}$. Depending on the values generated from the test, social preferences are categorized as follows: 1. altruist: SVO $> 57.15°$, 2. prosocial: $22.45° <$ SVO $< 57.15°$, 3. individualist: $-12.04° <$ SVO $< 22.45°$ and 4. competitive: SVO $< -12.04°$.

[Figure 2 about here.]

The SVO framework assumes that people have different motivations and goals for evaluating resource allocations between oneself and others. Also, the SVOs or social preferences are established to be stable for a long time (see, e.g., Van Lange et al., 2007, Brosig-Koch et al., 2011). Responses that are yielded from six primary items give complete categories of social preferences. Major reasons for using six primary slider measures developed by Murphy et al. (2011) are its simplicity and it is easy to implement in the Nepalese context. It is intuitive for subjects to understand even with a limited level of education. As is often done in psychology, we further simplify the four categories of social preferences into two categories of prosocial and proself types: "altruist" and "prosocial" types are categorized as "prosocial" subjects, whereas "individualistic" and "competitive" types are categorized as "proself" subjects (see Murphy et al., 2011). Subjects are informed

are consistent with group deliberations and decisions. Therefore, we decide to collect individual opinions through individual interviews "after" generations' decisions between A and B are made. The main results in our research regarding individual opinions and generation decisions that will be presented later are consistent with one another.

that the units represented in this game are points and that more points mean he/she will earn more real money, for details please see instruction given in figure 2.

In this game, the subject receives $150\,\mathrm{NPR}$ (NPR = Nepalese rupees) after applying some exchange rate to the points she obtains ($\approx 1.5\,\mathrm{USD}$) at maximum and $100\,\mathrm{NPR}$ ($\approx 1.0\,\mathrm{USD}$) on average. Subjects are instructed not to talk or discuss and the decision for SVO is made in private. To compute the payoff of the subjects from this game, we collect the answer sheets from all subjects, then we randomly match one subject with another subject as a pair. The experimental payoff in this SVO game is the summation of points from 6 selections by herself for oneself and 6 selection by the partner for the other. We also explain the methods of random matching and payoff calculation with the exchange rate for the real money incentive to subjects.

Critical thinking disposition

Critical thinking is defined as a cognitive process that consist of many different skills such as analysis, evaluation, inference, and inquisitiveness that is used appropriately for making a logical solution to a problem or a valid conclusion to an argument (Dwyer and Hogan, 2014). The logical thinking subscale of the critical thinking disposition scale was adopted in the questionnaire surveys, following Nakagawa (2015). This subscale consists of 13 items, which could be translated into English as follows: (1) "I am good at thinking about complex problems in an orderly fashion," (2) "I am good at collecting my thoughts," (3) "I am confident in thinking about things precisely," (4) "I am good at making persuasive arguments," (5) "I am confused when thinking about complex problems" (reversed item), (6) "I am usually the one to make decisions because my peers believe I can make fair judgments," (7) "I can concentrate on grappling with problems," (8) "I can continue working on a difficult problem that is not straightforward," (9) "I can think about things coherently," (10) "One of my shortcomings is that I am easily distracted" (reversed item), (11) "When I think about a solution, I am unable to think about other alternatives" (reversed item), (12) "I can inquire into things carefully," and (13) "I am constructive in proposing alternatives." Items were rated from 1 (strongly disagree) to 5 (strongly agree). The summation of rates from 1 to 5 over 13

items is the scale of critical thinking disposition, and the theoretical range is 13-65.

2.3 Experimental procedure

The experiments involve hiring local supporting staffs and research assistants (the first author is a chief administrator for the experiment). The experimental procedures are the same between urban and rural areas except for recruitment of subjects. In rural areas, subjects are informed in advance (a week ago) and asked to show up at the village schools and/or government agricultural community halls at a given date and time. To collect subjects, we are supported by local government offices known as village development committees (VDCs) and randomly select the households from the list of residents in rural areas (Central Bureau of Statistics, 2011). Based on the random selection, we send an invitation letter to the selected households and one member in a household is invited to participate in our experiments. The participation rate is approximately $95\,\%$ which becomes high due to proper incentives provided in this experiment.

In urban areas, we conduct occupation-based randomization by taking the desired number of subjects from each occupation such as banking, government, health, education, business, transportation and entertainment. The experiment is conducted at district health organization training halls in urban areas that are in the center of the cities consisting of many rooms. We send an invitation letter to different offices requesting people to participate in our experiment. One week prior to the experiment, the letters are dispatched to the selected organizations. We conduct experiments on the weekend and, due to proper incentives, the participation rate is high that is $80\,\%$. On an average, we paid $550\,\mathrm{NPR}$ ($\approx\ 5.00\,\mathrm{USD}$) to each subject including a fixed participation fee of $100\,\mathrm{NPR}$ ($\approx 1.0\,\mathrm{USD}$) in rural and urban areas.

[Figure 3 about here.]

Upon arriving at the locations, subjects are gathered in one hall and they are given experimental instructions in their native language (Nepali). Once everybody is present in a room, an experimenter (the first author) gives subjects a verbal explanation about experimental rules. To

maintain anonymity across generations, first, we confirm that subjects have fully understood the rules, and second, they are asked to proceed toward a door one by one and pick up a chip out of a bag that contains their generation ID and individual ID. According to the IDs, each subject goes to and sits in a specific room. In the end, we place the generations in separate rooms by their generation IDs. In this way, each subject can not observe and identify which person belong to a specific generation in a sequence (she knows only the members of her generation), however, they can realize that they are assigned to one generation within a sequence. However, they are not informed of which generation is the last within a sequence of generations.

The research assistants distribute questionnaires and explain the experimental procedures once again to subjects and keep them engage. In ISDG, the 1st generation makes deliberation up to 10 minutes where it is recorded and their generation decision is confirmed. Once a generation finishes making her decision after the deliberation, the members are asked to move to an individual interview room, one person by one person. This process is necessary to assure anonymity and privacy among subjects in a generations or across generations regarding how they answer in each interview. After the the 1st generation' decision and individual interviews, we proceed to the 2nd generation with the same procedures. A series of these routines are applied to the rest of the next generations from 3rd to 6th ones.

The previous generations' decisions are written on a white-board and the subsequent generations can see them if they are other than the 1st generation. Each subject in a generation is asked to confirm which generation they belong to in a sequence and the payoffs associated with options A and B. With this information, each generation deliberates and decides between intergenerational unsustainable option A and sustainable option B in an ascending order from the 1st generation to 6th generation. After the generation decision, each subject gets interviewed to state her "individual initial opinion" and "individual final opinion" to have supported A, B or N before and after deliberation. After the ISDG game and individual interviews, the SVO game follows. Finally, we ask subjects to finish questionnaire surveys for their sociodemographic and psychological information at the end of a session.

Our hypothesis in this experiment is that deliberation changes individual opinions and hence resolve ISD in societies. Theory of deliberative process establishes that deliberation can bring a change in individual opinions and resolve important problems in collective decision environments (see, e.g., Simon and Sulkin, 2002, Goeree and Yariv, 2011, Ban et al., 2012, List et al., 2013). Given this state of affairs, we hypothesize that deliberation induces a change in individual opinions and resolve ISD. However, the patterns of such changes in individual opinions may depend on the types of societies due to a difference of human nature and characteristics between rural and urban areas leading to a distinct outcome of generation decisions in ISDG. More specifically, this paper seeks to answer the following open questions: (i) Do rural and urban subjects change their opinions through deliberation in a different manner? (ii) Do such changes in individual opinions induce generations to resolve ISD in each area?

3 Results

Summary statistics about subjects' sociodemographic and psychological variables collected through questionnaire surveys are presented in table 1. In rural areas, $44\,\%$ of the subjects are male, while, in urban areas, $66\,\%$ of them are male. This fact reflects that a considerable portion of household heads are working away from home in rural areas (Massey et al., 2010). With respect to education, subjects in rural areas only possess 10 years of schooling on an average, whereas more than $50\,\%$ of the subjects in urban areas have an undergraduate degree with 16 years of schooling. With respect to employment, $88\,\%$ of the rural subjects engage in farming and forestry as their main activities, whereas only $37\,\%$ of urban subjects do so. The household income is lower in rural areas than in urban areas, and the percentages of a single family structure in rural and urban areas are, respectively, $47\,\%$ and $62\,\%$. The average family size does not differ between urban and rural areas. The critical thinking disposition is slightly lower in rural areas than in urban areas. With respect to social value orientation, $62\,\%$ and $47\,\%$ of subjects are prosocial in rural and urban areas, respectively. Overall, the summary statistics regarding the sociodemographic and

psychological variables presented in table 1 suggest that there are some differences between these two areas.

[Table 1 about here.]

[Table 2 about here.]

Generation choices for the intergenerational unsustainable option A and sustainable option B in ISDG are presented in table 2. It indicates that from a total of 121 generations (62 and 59 generations are in rural and urban areas, respectively), 90 ($74.38\,\%$) generations choose sustainable option B and 31 ($25.62\,\%$) generations choose unsustainable option A. Furthermore, in rural areas, from 62 generations, 52 ($83.87\,\%$) generations choose option B and 10 ($16.13\,\%$) generations choose option A. In urban areas, from 59 generations, 38 ($64.41\,\%$) generations choose option B and 21 ($35.59\,\%$) generations choose option A. We perform a chi-squared test with the null hypothesis that the distributions over generation choices between A and B across the two areas are the same. The result rejects the null hypothesis at a statistical significance of $5\,\%$ ($\chi^2 = 6.01, p = 0.014$). In summary, generations in urban areas more often choose the intergenerational unsustainable option A than generations in rural areas.

[Table 3 about here.]

The frequency and percentage of generation choices between A and B with respect to the number of prosocial members in each generation are presented in table 3. In both rural and urban areas, the choices of sustainable option B increase with the number of prosocial members in a generation. Another interesting fact is that a majority of generations choose B in rural areas when at least one subject in a generation is prosocial. In contrast, in urban areas, a majority of generations do not necessarily choose B even when one subject in a generation is prosocial. These facts illustrate that in addition to prosociality in a generation, there may be other factors, such as an area effect, that affect generation choices between unsustainable option A and sustainable option B. For

this purpose, we performed a logistic regression to characterize a generation choice with respect to prosociality, areas and other variables. Table 5 presents the marginal effects of an independent variable on the probability for a generation to choose option B, taking the generation choice of option A as the base group for the dependent variable in the logistic regression. In model 1, we include an area dummy and the number of prosocial members in each generation as independent variables. To check the robustness of the result in model 1, we add other sociodemographic and psychological variables such as gender, education, monthly income, single family type, critical thinking disposition and agricultural involvement at generational level in model 2 (see table 4 for the definitions).

[Table 4 about here.]

Model 1 in table 5 shows that the area dummy and a number of prosocial subjects in a generation are economically and statistically significant, demonstrating that generations in rural areas have a $14.2\,\%$ greater probability of choosing sustainable option B compared with generations in urban areas. Furthermore, an increase in a number of prosocial members per generation leads to a $21.5\,\%$ increase in the probability of choosing B relative to the probability of choosing A. These two findings are statistically significant at the $5\,\%$ and $1\,\%$ levels, respectively. In model 2 of table 5, gender, education, monthly income, single family type, critical thinking disposition, agricultural involvement and the previous generation's decision as explanatory variables have no effect on generation choices.[3] Overall, the analysis suggests that the number of prosocial members per generation and the area dummy are consistently significant and robust, irrespective of the regression specifications and they are important determinants for generation decisions.

[Table 5 about here.]

Table 6 presents the frequency and percentage of "individual initial opinion" to have supported A, B or to have been ambivalent (or no ideas) as N before deliberation and the "individual final

[3] We have tried several different specifications of the models, consistently finding the same tendency that the number of prosocial members and the area dummy remains significant $1\,\%$ and $10\,\%$ level.

opinion" after deliberation. When there are no individual opinion changes from initial to final opinions, such situations are coded as AA, BB or NN, where the first (second) letter represents the individual opinions before (after) deliberation. The other combinations of the two letters represent a situation in which a subject changes her individual opinions over a course of deliberation. For instance, AB describes a situation in which the subject initially had her initial opinion to support A before deliberation, but changed her final opinion to support B after deliberation. Subjects who do not change their opinions to support sustainable option B (i.e., subjects with BB) account for $78.49\,\%$ and $55.93\,\%$ in rural and urban areas, respectively (See table 6). Subjects who do not change their opinions to support unsustainable option A (i.e., subjects with AA) account for $9.14\,\%$ and $16.95\,\%$ in rural and urban areas, respectively. This result implies that a majority of subjects in rural areas have a consistent opinion of BB, whereas approximately half of subjects in urban areas exhibit variation in their opinions other than BB through deliberation.[4]

Table 6 also shows that individual opinion changes occur much more often in urban areas than in rural areas. These results are in line with the fact that more prosocial subjects are found in rural areas than in urban areas (see table 1). In fact, we identify that a majority of rural subjects are prosocial, expressing their opinions to support BB in their interviews. To identify the variation in initial and final opinions, we apply the coefficient of "unalikeability" as a concept of variability for an unordered categorical variable (Gordon, 1986, Kader and Perry, 2007, Frankfort-Nachmias and Leon-Guerrero, 2017).[5] We have identified that the coefficients of "unalikeability" in initial (final) opinions are 0.24 (0.32) and 0.46 (0.52) for rural and urban areas, respectively, confirming that urban subjects have a wider variety of initial and final opinions than rural subjects.

[Table 6 about here.]

[4]Subjects changing their opinions from A (N) to B, as AB (NB). $1.08\,\%$ $(2.15\,\%)$ and $6.78\,\%$ $(1.13\,\%)$ of subjects are classified as AB (NB) in rural and urban areas, respectively. These percentages are not necessarily high compared with those of other opinion shifts, such as BA or BN. For instance, $2.15\,\%$ $(5.38\,\%)$ and $6.21\,\%$ $(5.08\,\%)$ of subjects are classified as BA (BN) in rural and urban areas, respectively.

[5]The coefficient of "unalikeability" measures how often observations differ from one another within a same treatment group, and it is measured on a scale from 0 to 1 and higher the value is, the more unalike or variable the data are.

The previous literature has suggested that deliberation leads to collective decisions with unanimity (Gerardi and Yariv, 2007, Neilson and Winter, 2008, Gillet et al., 2009, Ruth and Danziger, 2016). With the data regarding individual opinion changes, we examine whether the aforementioned claim is true in ISDG. To this end, we introduce some terminologies to classify various cases of unanimity that can arise in ISDG. When all members in a generation have the same "individual initial opinion" of A, B or N before the deliberation, we call such a generation as a generation with "unanimity before deliberation;" otherwise, it is called a generation with "nonunanimity before deliberation." Similarly, when all the members in a generation have the same "individual final opinion" of A, B or N, it is called a generation with "unanimity after deliberation;" otherwise, it is called a generation with "nonunanimity after deliberation." With these definitions, all the generations fall into one of the following unanimity categories: 1. Unanimity and 2. Nonunanimity before and after deliberation.

Table 7 presents that, out of a total of 121 generations, 91 generations (39 and 52 in urban and rural areas) have unanimity before deliberation but only 75 generations (32 and 43 in urban and rural areas) are identified to have unanimity after deliberation. Thus, the number of generations that reached unanimity decline from 91 to 75 through deliberation. Furthermore, to statistically establish our result, we run a chi-squared test with the null hypothesis that the distributions of generations that reach unanimity before and after deliberations are the same. The result rejects the null hypothesis at $5\,\%$ significance level ($\chi^2 = 4.73, p = 0.029$), implying that deliberation in ISDG does not necessarily induce generations to reach unanimity. The previous literature has suggested that "deliberation leads to collective decisions with unanimity" (Gerardi and Yariv, 2007, Neilson and Winter, 2008, Gillet et al., 2009, Ruth and Danziger, 2016). However, in ISDG, such a claim is unlikely to be true.

[Table 7 about here.]

Next, we statistically analyze the factors that cause individual opinion changes through deliberation. For identifying such factors, we run logit regression taking an individual opinion change through deliberation as a dependent variable. The dependent variable is a dummy variable that

takes a value of 1 when a subject changes her opinion to support A, B or N before and after deliberation, such as AB, AN, BA, BN, NA and NB. The independent variables include the area dummy, critical thinking disposition, preunanimity, minority dummy, social value orientation and sociodemographic factors such as gender, age, education, monthly income, family size and agricultural involvement. The definitions of all the variables are summarized as "variables at individual level" in table 4. Table 8 presents the marginal effects of an independent variable on the probability for a subject to have an opinion change in models 1 and 2. In model 1, we do not control for sociodemographic variables. We include sociodemographic variables in model 2 for a robustness check.

The area dummy, critical thinking disposition and preunanimity dummy have a negative effect on an individual opinion change, while the minority dummy has a positive effect on opinion changes through the deliberation in both models 1 and 2. On the other hand, the sociodemographic variables in model 2 do not exhibit any effect.[6] The area dummy is statistically significant in that rural subjects are $10.1\,\%$ less likely to change their opinions through the deliberation, compared to urban subjects. This rural-area effect is considered strong because a high portion of rural subjects ($78.49\,\%$) consistently chose sustainable option B (See table 6). A possible explanation that there is a less variation in culture and the ways of thinking among rural people because they might have similar social learning and experiences. In other words, The culture and ways of thinking are homogeneous, being passed from generation to generation through the social interactions in rural area, leading to less variation in people's ideas and concepts during the deliberation in experiments (Hooper et al., 2015, Schniter et al., 2015).

[Table 8 about here.]

The results in model 1 show that a critical thinking and unanimity before deliberation are negatively associated for a member of a generation to change his/her opinions through deliberation.[7]

[6] We have also tried different specifications of regressions in addition to models 1 and 2, but the qualitatively identical results have been obtained.

[7] One-unit-scale increase in critical thinking disposition leads to a decrease of $1\,\%$ in the probability for a member of a generation to change his/her opinions through deliberation at $1\,\%$ significance level.

However, the magnitude of the effect of critical thinking on opinion changes could be considered rather small. Subjects with higher critical thinking abilities should be able to judge and understand the quality of arguments with a logical validity in deliberation. Therefore, they are less likely to change their opinion, being qualitatively consistent with previous researches (Nakagawa, 2015, Howarth et al., 2016, Bear and Rand, 2016). Furthermore, when generations have unanimity before deliberation (or preunanimity in the regression), the probability for their members to change their opinions decreases by $10.1\,\%$ at $5\,\%$ significance level, compared with generations without the unanimity. Overall, whether or not members in a generation have the same opinion, i.e., "unanimity before deliberation," is identified to be a key factor for determining whether subjects in the generation change their opinions. Finally, the results also demonstrate that a subject with a minority of her initial opinion in a generation is $16.2\,\%$ more likely to change her opinion, compared with non-minority subjects, at $1\,\%$ significance level.

We have identified that area dummy, critical thinking disposition, preunanimity dummy and minority dummy are identified to be the major factors related to individual opinion changes. In addition, we have found that the direction of the opinion changes does not necessarily move toward more sustainable option B, indicating that the deliberation can not induce an opinion change to be supportive for future generations. In summary, our results suggest that deliberation does not necessarily resolve intergenerational sustainability. First, we have demonstrated that subjects in rural areas choose more sustainable option B than those in urban areas and also the number of prosocial members per generation is a key factor for that. Next, urban subjects have a wider variety of individual initial opinions and support an unsustainable option more often than rural subjects do. It also shows that individual opinions change through deliberation when subjects in a generation do not share the same initial opinion, reflecting that more urban subjects change opinions. To demonstrate how deliberation is effective at maintaining intergenerational sustainability, we interviewed subjects to elicit individual initial opinion and final opinion to trace changes in individual opinion during deliberation. Tables 6 to 8 demonstrate that deliberation does not induce individuals and generations to support and to choose sustainable opinion B. Now, we can answer to the

two questions posed as our hypotheses: (1) Urban subjects change their opinions more often than do rural subjects through deliberation, and (2) the individual opinion changes that mainly occur in urban areas do not work in the direction to enhance intergenerational sustainability. In conclusion, deliberation shall not be a resolution for ISD problems.

3.1 Discussion

Urban and rural areas function in different manners in terms of their environment, uses of technologies and social interactions among people. In many cases, the basic city life in Kathmandu and Pokhara does not require people to have human interactions or intimacy even with their colleagues. In contrast, people in rural areas have close interactions and intimacy with their neighbors owing to their direct dependence on agriculture-based activities. In other words, rural life in Nepal induces people to interact with neighbors and others on a daily basis, whereas urban life does not. With these realities, it is our belief that the difference in how people interact with others affects social preferences and behaviors. Therefore, a higher proportion of prosocial people are found in rural areas in comparison to urban areas. Prosocial preferences directly affect people's decisions about how to live, such as unplugging cell phones, using public transport to commute work or installing a solar panel on a roof for energy (Van Lange et al., 2007). On the individual level, the effects of such activities are minimal, but in aggregate, they are substantial. Our research demonstrates that prosociality is a key driver that determines not only everyday life events but also intergenerational sustainability.

Our results demonstrate that deliberative process is not effective at resolving ISD. This result appears to be in sharp contrast with the previous literature claiming that deliberation leads to more fair and better collective decisions in some class of social problems (Cardenas, 2000, Cardenas et al., 2000, Neilson and Winter, 2008, Gerardi and Yariv, 2007, Gillet et al., 2009, Cason et al., 2012, Ghate et al., 2013, Ruth and Danziger, 2016). However, there is a clear distinction between ours and previous works. In ISDG, there is no room of having a Pareto improvement because either the current generation or the future generation needs to bear the cost for maintaining intergener-

ational sustainability, whereas previous works employ the prisoner's dilemma or a public goods game where there is a room of having a Pareto improvement. Given these results, we conjecture that deliberative process may not be effective at resolving problems in which there are no possibilities of Pareto improvement, such as ISDG. In such a case, we conjecture that some new social mechanisms in addition to deliberation are necessary.

A novelty of our experimental design is conducting interviews to identify individual opinion changes over a course of deliberation. The interviews reveal that there is a fundamental difference in terms of how deliberation affects individual opinions in ISDG. In rural areas, approximately $80\,\%$ of subjects consistently support sustainable option B without any opinion change during deliberation, whereas approximately half of urban subjects do not. In particular, we find that individual opinion changes occur more frequently in urban subjects. This is due to the fact that urban subjects have a wider variety of individual initial opinions than rural subjects, leading to more conflicts of interests or opinion changes during the deliberation of generations. As a result, deliberation does not seem to induce subjects and generations to support sustainable option B. Overall, our findings demonstrate that deliberative democracy does not necessarily resolve ISD.

4 Conclusion

This paper has analyzed how deliberation changes individual opinions and then can be a resolution for intergenerational sustainability dilemma (ISD) in societies by conducting the framed field experiment in two Nepalese contexts (urban and rural areas). Our result demonstrates that urban subjects have a wider variety of individual initial opinions and support an unsustainable option more often than do rural subjects, being consistent with the fact that $53\,\%$ of urban subjects are proself and a majority of rural subjects are prosocial. It also shows that individual opinions change through deliberation when subjects in a generation do not share the same initial opinion, reflecting that more urban subjects change opinions. However, we identify that such changes do not necessarily work in the direction to enhance intergenerational sustainability. Thus, urban genera-

tions remain to choose an unsustainable option than do rural generations. Overall, our experiment demonstrates that deliberation shall not be a resolution for ISD.

We note some limitations of the study and directions for future research. First, our experiment is instituted under nonoverlapping generations to focus only on the problems of ISD. In reality, however, generations are overlapping in societies. Future research should address ISD with overlapping generations. Second, although we find that deliberation does not resolve ISD, future research may be able to find a new type of social mechanisms, potentially with deliberative process, which resolves ISD. Because many countries are under democracy, it is important to find new mechanisms that fit into deliberative process. Finally, this research does not fully utilize the contents of generations' discussions for analyzing why individual opinion changes occur in deliberation along with generation decisions. Future research should be able to characterize the detailed dynamic process for individual opinion changes and generation decisions via qualitative deliberative analysis of discussion contents, as is done in psychology and political science.

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Figure 1: Urban and rural areas in Nepalese fields

Figure 2: Instructions for the "slider method" for measuring social value orientation

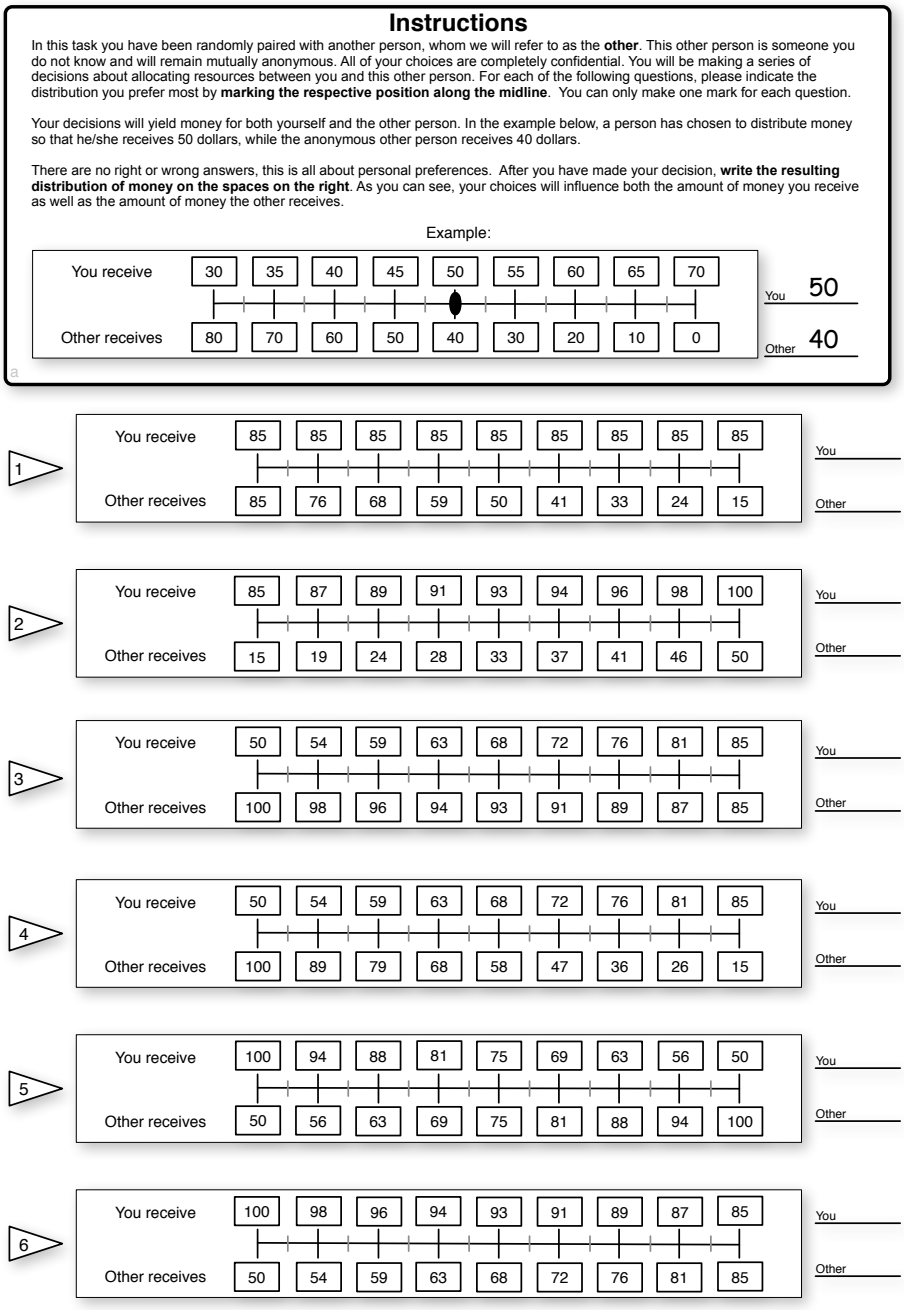
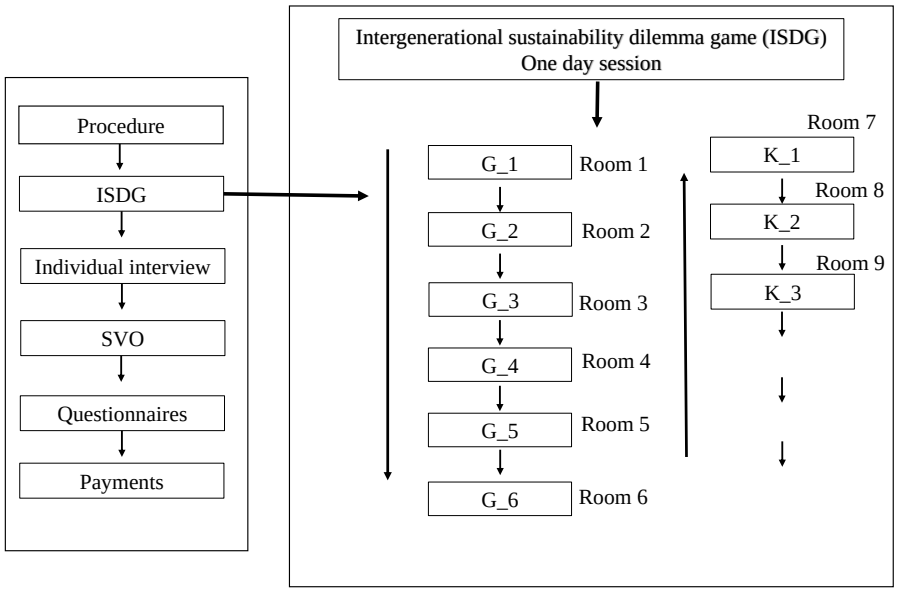


Figure 3: Structure of experiment and data collection procedures



List of Tables

Table 1: Summary statistics

Variables	Urban (59 generations, 177 subjects)					Rural (62 generations,186 subjects)				
	Mean	SD[1]	Median	Min	Max	Mean	SD	Median	Min	Max
Age[2]	33.77	11.38	32.50	18.00	56.00	33.27	11.54	30.5	16.00	66.00
Gender[3]	0.66	0.47	0.00	0.00	1.00	0.44	0.50	0.00	0.00	1.00
Education[4]	15.20	3.42	16.00	5.00	18.00	10.18	2.86	10.00	1.00	18.00
Agricultural involvement[5]	0.37	0.50	1.00	0.00	1.00	0.88	0.33	1.00	0.00	1.00
Monthly income (in NPR 10,000)[6]	5.10	8.05	3.40	1.00	90.00	0.31	4.05	1.50	0.50	30.00
Single family[7]	0.62	0.48	1.00	0.00	1.00	0.47	0.51	0.00	0.00	1.00
Family size[8]	3.03	0.94	3.00	1.00	5.00	3.15	1.13	3.00	1.00	5.00
Cognitive & psychological variables										
Critical thinking disposition[9]	48.14	7.12	49.00	23.00	65.00	47.62	6.45	48.00	25.00	65.00
SVO[10]	0.47	0.50	1.00	0.00	1.00	0.62	0.48	1.00	0.00	1.00

[1] "SD" stands for standard deviation.
[2] Age is a continuous variable given in years.
[3] A dummy variable that takes the value 1 when the subject is male and 0 otherwise .
[4] Education represents years of schooling.
[5] Agricultural involvement is a dummy variable that takes the value 1 when a subject is stably employed or engaged in the agricultural sector and 0 otherwise.
[6] Monthly income is given in Nepalese rupees (NPR).
[7] Single family is a dummy variable that takes the value of 1 if the participant is in a single family structure and 0 otherwise.
[8] Family size is the number of family members.
[9] Critical thinking disposition is the summation of rates from 1 to 5 over 13 items, and the theoretical range is 13-65. In each item, a question is posed, and a subject is asked to choose among 1 "strongly disagree," 2 "disagree," 3 "neutral," 4 "agree" and 5 "strongly agree."
[10] "SVO" is a dummy variable that takes a value of 1 when a subject is prosocial and 0 otherwise.

Table 2: The frequency and percentage of generation choices of A and B (percentage in parenthesis)

Generation choices between A and B	Area		Total
	Urban	Rural	
A	21 (35.59 %)	10 (16.13 %)	31 (25.62 %)
B	38 (64.41 %)	52 (83.87 %)	90 (74.38 %)
Total	59 (100.00 %)	62 (100.00 %)	121 (100.00 %)

Table 3: The frequency and percentage of generation choices between A and B with respect to the number of prosocial members in each generation

# of prosocial members per generation	Urban		Rural	
	A	B	A	B
0	5 (8.48 %)	3 (5.10 %)	7 (11.29 %)	0 (0.00 %)
1	10 (16.95 %)	10 (16.95 %)	3 (4.84 %)	10 (16.13 %)
2	6 (10.17 %)	23 (40.00 %)	0 (0.00 %)	25 (40.32 %)
3	0 (0.00 %)	2 (3.39 %)	0 (0.00 %)	17 (27.42 %)
Subtotal	21 (35.59 %)	38 (64.41 %)	10 (16.13 %)	52 (83.87 %)
Total	59 (100 %)		62 (100 %)	

Table 4: Definitions of the variables included in the regressions

Variables	Definition of variables included in regressions
Variables at generation level	
Generation choices between A and B	A dummy variable that takes 1 if the generation choose option B, otherwise 0.
# of prosocial members in a generation	A number of prosocial members in each generation.
Area dummy	A dummy variable that takes 1 if the generation is from the rural area, otherwise 0.
Gender	A variable that represents the number of males in each generation.
Education	A variable that represents average years of schooling over three subjects in each generation.
Monthly income	A variable that represents an average household income of three subjects in each generation.
Single family	A variable that represents a number of members in a generation that have a single family structure.
Agricultural involvement	A variable that represents a number of members in a generation who engage in agriculture.
Previous generation decision[1]	A dummy variable that takes 1 if the previous generation chooses option B, otherwise 0.
Variables at individual level	
Individual opinion change	A dummy variable that takes 1 when a subject changes her individual opinion to support A, B or N before and after deliberation or over a course of deliberation.
Critical thinking disposition	A variable that represents the summation of rates from 1 to 5 over 13 items of questions. each subject answers in her questionnaire and the theoretical range is 13-65
Preunanimity	A dummy variable that takes 1 when all members in a generation have same opinion between A or B before deliberation, otherwise 0.
Minority	A dummy variable that takes 1 when the subject have a different opinion from other two members in a generation, otherwise 0.
SVO	A dummy variable that takes 1 when the subject is identified as prosocial, otherwise 0.
Gender	A dummy variable that takes 1 when the subject is male, otherwise 0.
Agricultural involvement	A dummy variable that takes 1 when the subject engages. in agriculture sector otherwise 0
Education	A variable that represents the subject's years of schooling.
Single family	A dummy variable that takes 1 if the subject has a single family, otherwise 0.
Monthly income	A variable that represents monthly household income.

[1] For the 1st generation this variable is missing.

Table 5: Marginal effects of logit regression for generation choices between A and B where the dependent variable of generation choices takes the value 1 with option B, otherwise 0.

Variables	Model 1	Model 2
Area dummy (Urban areas $= 0$)	0.142**	0.188*
	(0.065)	(0.113)
# of prosocial members in a generation	0.215***	0.213***
	(0.033)	(0.029)
Gender		-0.013
		(0.046)
Education		0.016
		(0.016)
Monthly income		-0.000
		(0.000)
Single family		0.013
		(0.039)
Critical thinking disposition		(-0.007)
		(0.009)
Agricultural involvement		-0.006
		(0.042)
Previous generation's decision		-0.008
		(0.085)
Sample size	121	102

***significant at $1\,\%$ level, **significant at $5\,\%$ level and *significant at $10\,\%$ level.

The Wald χ^2 statistics are 41.47 and 34.44 in models 1 and 2, respectively.

Table 6: The frequency and percentage of change in individual opinions for supporting option "A," "B," or "N" ambivalent/no ideas before and after the deliberation (percentage in parenthesis)

Individual opinion change	Areas	
	Urban	Rural
AA	30 (16.95 %)	17 (9.14 %)
AB	12 (6.78 %)	2 (1.08 %)
AN	9 (5.08 %)	2 (1.08 %)
BB	99 (55.93 %)	146 (78.49 %)
BA	11 (6.21 %)	4 (2.15 %)
BN	9 (5.08 %)	10 (5.38 %)
NN	2 (1.13 %)	0 (0.00 %)
NA	3 (1.69 %)	1 (0.54 %)
NB	2 (1.13 %)	4 (2.15 %)
Total	177 (100.00 %)	186 (100.00 %)

Table 7: The number of generations with unanimity before and after the deliberation

Deliberation	Unanimity	Non-unanimity	Total
Before	91	30	121
After	75	46	121

39 generation out of 59 generation have unanimity before deliberation in urban, whereas 52 out of 62 generation in rural areas.

Table 8: Models 1 and 2: marginal effects of logit regressions for individual opinion change

	Model 1	Model 2
Area dummy (Urban areas = 0)	−0.101**	−0.108*
	(0.040)	(0.060)
Critical thinking disposition	−0.010***	−0.010***
	(0.003)	(0.003)
Preunanimity	−0.101**	−0.105**
	(0.045)	(0.049)
Minority	0.162***	0.141**
	(0.060)	(0.065)
Including other socio-demographic variables in model 2		
SVO dummy (Proself = 0)		−0.020
		(−0.042)
Gender (Base group = female)		0.063
		(0.046)
Age		−0.001
		(−0.002)
Education (Years of schooling)		−0.010
		(0.007)
Monthly income		0.000
		(0.000)
Family size		−0.014
		(0.021)
Agricultural involvement		0.015
		(0.051)
Sample size	363	331

***significant at 1 % level; **significant at 5 % level; *significant at 10 % level.
The Wald χ^2 statistics are 43.06 and 42.28 in models 1 and 2, respectively, and they are significant at 1 % level.